Year in Review 07-08

The Laboratory is a research leader in a vast array of scientific and technical areas in national security. Homeland security has become a special focus of Laboratory research and development. A Lab-developed airport-screening device that detects and identifies liquids and gels is poised to enter real-world testing, while the Lab's aerial-borne chemical identification system responded to disasters and emergencies throughout the country. Meanwhile, Lab instruments and power supplies continue to play key roles in ongoing and future space missions.

A state-of-the-art, compact, multipurpose sampler gun developed at the Lab can be used to collect and track a wide variety of samples, such as radiological, chemical, and biological samples. The device includes a Pocket PC with graphical touch-screen user interface, temperature probe, sonic distance sensor, real-time force sensor, electronic compass, global positioning system receiver, digital camera, microphone, barcode scanner, memory card writer, and speaker-independent voice recognition module. The sampler gun has been successfully tested during hazmat field testing exercises with LANL and U.S. Army first responders. LANL is currently in the process of transferring the technology to the commercial sector.

A through-the-earth communication system—possessing new, advanced capabilities developed by the Lab—passed a series of tests with better-than-anticipated performance. The system will provide reliable communication for first responders, rescue teams, and workers in extreme environments such as mines, subways, tunnels, and large buildings. It uses magnetic-frequency technology to provide two-way voice communication to depths of several hundred feet. The system's features stem from research and development conducted by the Lab's Superconductivity Technology Center.

A robotic "thinking telescope" named RAPTOR surprised the world with its unexpected detection of the early optical light from gamma-ray bursts, the super-energetic cosmic explosions believed to announce the birth of stellar-size black holes. RAPTOR, along with Burst Alert telescope software, also developed at Los Alamos, provided detection and automatic data recording capabilities during every phase of the event. Now it is being transformed into a next-generation global network of survey and fast-response telescopes, a pathfinder technology for exploring the dynamic universe in real time and making significant discoveries without human intervention.

Using a sophisticated mathematical model developed at Los Alamos, researchers discovered that HIV reproduces much faster than previously known. An international research team used the modeling approach to obtain, for the first time, a precise estimate of the number of offspring produced by a single Simian Immunodeficiency Virus, first-cousin to the virus that causes AIDS in humans. Results were surprising, showing that immunodeficiency viruses can produce 10 to 100 times more progeny than previously postulated. In another research effort, the world's first portable acoustic cytometer is undergoing development by a research team at the Laboratory’s National Flow Cytometry Resource. Flow cytometry is the diagnostic tool of choice for HIV, but costs and technological limitations have held it back in developing countries. The portable acoustic cytometer is designed to change this: compact, low-cost, with high throughput and high sensitivity. The device is the recipient of an R&D 100 award.

Teams of scientists from the Lab and several European research institutions made advances in the development of protocells, systems of molecules that exhibit living cell-like behavior.
Protocells would constitute a major step toward the manufacture of devices capable of lifelike functions—a computer, for example, that can repair itself or microscale machines capable of metabolizing carbon dioxide to reduce the threat of global warming.
Lab research in this area, which could have significant implications for understanding the origin of life on Earth from nonliving chemical processes approximately 4 billion years ago, is being conducted by the Los Alamos Protocell Assembly project.

Several current, past, and future NASA space missions continue to rely on Lab research and development.
The recently launched Dawn mission to asteroids Vista and Ceres carries a gamma-ray and neutron detector built by the Lab.
The spectacularly successful Cassini spacecraft now orbiting Saturn is powered by LANL-supplied radioisotope thermoelectric generators and carries a pair of Lab-built ion-mass and ion-beam spectrometers.
The completed Genesis mission—despite a high-speed crash into the Utah desert during its 2004 return to Earth—yielded a vast amount of data now being analyzed by Lab researchers and others, significantly advancing our understanding of solar system evolution.
For the Mars Science Laboratory mission scheduled for launch in 2009, the Lab has built ChemCam, which will use laser pulses to dissolve rocks and employ spectrographs to determine the composition of the resulting gases.

A Laboratory astrophysicist and colleagues discovered intriguing evidence from a superbright supernova observed last year—evidence that might explain the mysterious double flash exhibited by such events.
Last year's supernova was exceptionally energetic, arriving with a flash 100 times brighter than typical.
According to the researchers, there is evidence that the star expelled lobes of relatively cool gas before it exploded. Material from the primary supernova explosion that followed (flash number one) then collided with the lobes, violently heating them (flash number two).

Superconducting continues to challenge theorists: 50 years after publication of the first widely accepted theory on the physics of superconductors, researchers from the Lab, the University of Edinburgh, and Cambridge University proposed the existence of a second mechanism, suggesting that in certain materials superconductivity arises from an absence of the interactions that normally take place between electrons and the vibrational motion of the material’s structure.
The existence of a second mechanism could mean that it would be possible to develop an entirely new class of superconductors, which might be better suited to practical applications.

Hydrogen is a promising alternative-energy source. A major challenge is to develop suitable materials to

store it under a variety of conditions. New high-pressure instrumentation at the Lujan Center High Pressure Preferred Orientation spectrometer is helping technologists address the challenge, revealing details of the uptake and release, structure, and dynamics of hydrogen in compounds such as clathrates and metal organic frameworks, allowing in-situ, real-time examination of reaction kinetics with methane and hydrogen clathrates.

Proton radiography experiments were performed at LANSCE to study the behavior of small samples of plutonium after detonation of small quantities of high explosives. Radiographic and velocimetric data from these experiments provide valuable information for weapons programs.

Lab researchers completed one of the largest cosmological supercomputer simulations ever undertaken. Under the name Enzo, the experiment crammed 2.5 percent of the visible universe into a model of a region more than 1.5 billion light-years across.
Large-scale simulations such as Enzo open the door to better astronomical observation techniques and a better understanding of the evolution of the universe.

The Alliance for Advanced Energy Solutions reached the level of 16 collaborative projects, with an overall value to the Laboratory in the millions. The partnership between LANL and Chevron, established in 2004, helps address critical technology needs of the oil and gas industry while advancing national energy security.

Plutonium-239 and -238 sealed sources of U.S. origin were repatriated from Italy and Brazil through NNSA's Off-Site Source Recovery Project (OSRP) at Los Alamos National Laboratory. The OSRP also repatriated U.S.-origin source-containing devices for the first time.
OSRP teams packages hundreds of U.S.-origin sealed sources and disassembled source-containing devices in Chile, Denmark, and Sweden, as well as answered requests from Germany, Israel, and Switzerland for future repatriation of U.S.-origin sealed sources. Additional nations in negotiation for or already scheduling retrievals include Nigeria, Austria, Peru, Jordan, Tunisia, and the Democratic Republic of Congo.

Global positioning system satellites carrying the latest x-ray instruments from Los Alamos National Laboratory were launched successfully in December 2007 and will begin providing GPS signals to the world for precise timing and navigation applications. These applications range from cell phones and banks to military craft and will help meet new, post-Cold War threats, simplify the management of satellite constellations, and enhance the fidelity of space environment coverage by providing dosimetry measures on all GPS satellites.
For LANL, this launch represents a major milestone, as this satellite carries the ninth of its nine combined x-ray spectrometer and particle dosimeter subsystems provided to the U.S. Air Force for the current generation of GPS satellites. Previous generations of GPS satellites carried separate LANL burst detection x-ray instruments on approximately 80 percent of the space vehicles and burst detection dosimeter instruments on the other 20 percent of the spacecraft. Starting in 1994, LANL worked to combine these two functions into a single instrument having the same space and weight as a single one of the previous boxes while retaining all previous space environment particle sensing and doubling the number of x-ray detection channels.

A magnetic resonance imaging machine tailored to the needs of airport security is under development by a Lab team. The device, named MRI Screen, is designed to eliminate the need for the 3-1-1 rule for carry-on liquids, gels, and aerosols. The Department of Homeland Security has scheduled tests of the device this summer at Albuquerque's international airport.

An airborne chemical and radiological detection system was deployed to several disaster areas during the year.
Known by the name ASPECT, the system detects dangerous substances on the ground or in the air as it cruises back and forth over disasters such as train wrecks, chemical facility explosions and fires, and forest fires.
The information gathered could be critical to actions taken by emergency responders and agencies such as local fire departments, state fire-fighting services, and homeland security.

Working with the Air Force, LANL developed and

fielded a wide-area persistent surveillance capacity called Angel Fire for the U.S. Marine Corps. The system provides warfighters with real-time situational awareness.